



SUBJECT: Powering-Down the Apollo Command  
Module in an Emergency - Case 330

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FROM: W. H. Hodge

MEMORANDUM FOR FILE

In the event of an emergency, such as a fire in the Apollo Command Module, crew response might include separation of the electrical energy sources - fuel cells and batteries - from possible short circuits and overheated wiring and equipment. This could be done in two ways:

1. "Power-off," i.e., disconnecting the distribution busses from the sources; or
2. "Powering-down," i.e., removal of all but a few highly desirable loads from the busses.

The positive aspect of "power-off" is that it might be done rather quickly because relatively few manual operations are required to remove the busses from the outputs of the fuel cells and batteries:

- (a) Six switches arranged in two groups of three each on the Main Display Console in front of the Systems Engineer disconnect the fuel cells from the busses;
- (b) Six circuit breakers located in a group in the relatively inaccessible Lower Equipment Bay could be used to disconnect the batteries from the busses.

In addition, removal of the sources would increase the probability of relieving a problem such as fire since more circuitry would be without energy in a shorter time.

Total de-energization of the spacecraft seems unacceptable, however, for reasons such as the following:

1. If any of the astronauts is in his suit with the helmet on, the suit compressor should not be turned off for longer than 10 to 15 seconds because of CO<sub>2</sub> asphyxiation from lack of air circulation;\*

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\*"Review of Atmosphere Selection for Manned Space Program,"  
by T. A. Bottomley, Jr. (To Be Released)

2. Lighting would be highly desirable to aid further emergency procedures;
3. Communications with the ground and among the crew would aid the procedure.

Therefore, it seems that only a partial loss of power is acceptable.

The latter course (powering down) would call for maintaining certain highly desirable electrical loads. At a bare minimum, these should probably include the following:

- (1) Suit compressors
- (2) Interior floodlights
- (3) Communication equipment
- (4) Essential instrumentation.

Unfortunately, there are a number of problems in quickly powering down within the constraints of the present electrical power system:

1. No easily isolated subset of essential equipment, such as listed above, exists and thus a selective disconnect process is necessary. This operation, probably necessitating a checklist because of the large number of circuit breakers in the spacecraft, may take an appreciable time.
2. If the fuel cells are left on the busses, and loads selectively removed by opening circuit breakers, the thermal inertia of the fuel cells causes the bus voltage to rise above its acceptable limit (31 VDC).<sup>\*</sup> To circumvent such out-of-tolerance bus voltage, gradual load removal is necessary. This permits the fuel cell temperatures to fall enough to bring the bus voltages within the acceptable range.

A consideration affecting any powering down procedure is the fact that the switches and circuit breakers that have to be employed may not be within reach at the time of the emergency.

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<sup>\*</sup>Mission Modular Data Book, First Block II Manned Mission, Section 3.2.2, December 1, 1966

For example, the circuit breakers that connect the batteries to the distribution busses are located in the Lower Equipment Bay and are, therefore, out of reach of the crew when they are strapped in their couches.

In summary, neither "powering-off" nor selective "powering-down" seems advisable as a course to follow in case of an emergency. It seems that completely turning off the Command Module power is not feasible at all. A selective powering-down might, however, provide a valuable aid in an emergency, but would not be practical unless the following actions are taken:

- (1) Identification of a subset of necessary and/or highly desirable loads is identified; and
- (2) Provisions are made for allowing quick isolation of these loads from the remainder of the electrical system; the fuel cell thermal characteristics mentioned above would have to be considered in making any provisions for quick isolation.

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